CHAPTER 7

Classifying the Shumagin and Alaska Apollo deposits

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Geological and Geophysical Setting of the Gold-Silver Vein Systems of Unga Island, Southwestern Alaska

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INTRODUCTION

The purpose of classifying these and other known deposits and occurrences into deposit models is that this kind of information can demonstrate possible types of yet-to-be discovered deposits. (It is not the only way however.) The mineral deposit models in USGS Bull. 1693 and subsequent related publications were specifically designed to be an integral part of three-part quantitative assessments (Singer, 1993). Criteria in these models are used to help classify these deposits.

The first part of a descriptive model describes the geologic environments in which the deposits are found; the second gives the identifying characteristics of the deposits. Thus, the first part plays a primary role in the delineation process in that it describes the general setting of the deposit type. The second part of the descriptive model helps classify known deposits and occurrences into types which aids the delineation process; in some cases, geologic environments not indicated on geologic maps are identified by the types of known deposits and occurrences.

This very practical approach has several consequences. Existing or newly created models must be in a form such that information in the model can be used as a basis of delineation of permissive tracts. That is, the model must link the kinds of information available in assessments such as geologic and geophysical maps to the possibility of the existence of the deposit type. These descriptive models are also linked to the grade and tonnage models which, in turn, are linked to number of undiscovered deposits estimates.

Thus, all of these different kinds of information in turn can be used to classify known deposits or occurrences. Deposit types considered in this study are: (1) Sado epithermal vein gold-silver (Mosier and others, 1986), (2) Comstock epithermal vein gold-silver (Mosier and others, 1986), (3) Creede epithermal vein gold-silver (Mosier and others, 1986), (4) polymetallic vein (Cox, 1986), and (5) no existing model. In the following analysis, classification of the Shumagin and Alaska-Apollo deposits is considered with respect to mineralogy, geologic setting, grades and tonnages, and other deposits in the region.

In tests of the ability of probabilistic neural networks to classify deposits into types based on mineralogy, Singer and Kouda (1997a, 1997b) used the presence or absence of ore and alteration mineralogy in well-typed deposits to train the network. Their tests demonstrated the ability of probabilistic neural networks to correctly classify over 92 percent of mineral deposits by type. Probabilistic neural networks (Masters, 1995) require no assumptions about distributions of random variables used to classify; they even can handle multimodal distributions. They have the ability to provide mathematically sound confidence levels and are relatively insensitive to outliers.

MINERALOGY

According to White and Queen (1989), the Shumagin deposit contains adularia, arsenopyrite, chlorite, galena, gold, marcasite, sericite, pyrite, rhodonite, sphalerite, and Mn oxides. The Alaska-Apollo deposit contains adularia, chalcopyrite, copper, galena, gold, pyrite, and sphalerite (Wilson and others, 1996).

Using the neural network from Singer and Kouda (1997a) in which the training set was the presence or absence of 56 reported minerals in eight deposit types, including Sado, Comstock, and Creede epithermal vein, the trained network was tested with the published mineralogy of the Shumagin and the Alaska-Apollo deposits. The neural network classed one deposit as Comstock type and the other as Sado type.

GEOLOGIC SETTING

The geologic difference in the subtypes of adularia-type epithermal gold deposits is based on the nature of the rocks through which the hydrothermal fluids might have passed (Mosier and others, 1986). In most cases, these rocks are considered the 'basement' rocks (rocks to 1 km below) of the deposit.

According to Riehle and others (Chapter 2) and Riehle (Chapter 4), the rocks in, near, or possibly under the Shumagin and Alaska Apollo deposits are: the Popof volcanics, the Unga Formation, undifferentiated hypabyssal to intrusive domes, and various basaltic andesite, dacitic, and rhyolitic domes. The Popof volcanics are mainly andesitic flows and minor flow breccias with local dacitic or basaltic flows and some volcaniclastic rocks. The Unga Formation contains conglomerate and interbedded sandstone, siltstone, tuff, and lahar deposits(?).

The Creede type epithermal districts have basement rocks containing evaporites and carbonates or rocks with trapped seawater (Mosier and others, 1986). Although the Unga Formation might have locally trapped seawater, it seems unlikely, and many of the other epithermal deposits in this part of Alaska should also have have been affected by locally trapped seawater.

Comstock type districts have basements containing clastic sedimentary rocks or their metamorphic equivalents (Mosier and others, 1986). Igneous basements are common for Sado type districts (Mosier and others, 1986). Sado type districts typically are hosted in volcanic rocks and rest on predominantly granite or volcanic basement. The igneous and sedimentary rocks near the Shumagin and Alaska Apollo deposits allow either the Sado or the Comstock epithermal vein models.

GRADES AND TONNAGES

When only one or two explored examples of a deposit type are known in a particular area, it is common to believe that they represent a special subtype or new type because they are almost never exactly the same as the "typical" deposit in every respect. Deposits will generally not have the median tonnage or grade of the type in question and may vary somewhat in mineralogy. To avoid the situation where every deposit is considered unique and therefore prediction is not possible, the well-explored deposits in an area should be tested to see if they are statistically different from the general model (Singer, 1993).

Grade and tonnage models have the form of frequency distributions of tonnages and average grades of well-explored deposits of each type. They serve as models for grades and tonnages of undiscovered deposits of the same type in geologically similar settings. Estimates of numbers of undiscovered deposits are not meaningful unless the deposits estimated are defined by grade and tonnage models.

Because of the relatively long history of mining and exploration in these deposits (Wilson and others, 1996), we assume that they are well-explored. Grade and tonnage models for the epithermal deposit types represent districts so in order to compare the tonnages of these Alaskan deposits to the published models, the tonnages of the Alaska-Apollo and Sitka deposits were combined.

Although tonnages of the Alaskan deposits seem low, the tonnages cannot be shown to be significantly lower than would be expected from a random sample of two districts from Creede, Comstock, or Sado types (Singer and others, 1993) (Using a 't' test, the probability that these districts are of a Creede type is 0.33, of a Sado type is 0.37, and of a Comstock type is 0.03.) Good data for base metal grades are not available for the Alaskan districts; however, indirect evidence suggests that the base metal grades are too low for

Creede type districts. Similarly, the base metal grades seem too low for deposits that fit the polymetallic vein model.

OTHER DEPOSITS IN REGION

A number of occurrences with mineralogy similar to the Alaska-Apollo and Sitka deposits have been recorded in the region (Wilson and others, 1988). This suggests that the Alaska-Apollo and Sitka deposits are not unique and the geologic environment has regional extent.

The northernmost of these other deposits occur along the Aquila-Shumagin Fault Zone within 3-4 miles of a porphyry copper prospect (Zachary Bay) (Wilson and others, 1988). Polymetallic vein deposits are common peripheral to porphyry copper deposits. However, in this case, there appears to be an age difference precluding any genetic relationship. Multiple dates on the Alaska-Apollo and Sitka deposits give ages of 31-34 m.y. and one date on sericite from an altered sample near the porphyry copper occurrence is 14.6 m.y. (see Riehle and others, Chapter 2, Table 1).

SUMMARY

Based on all of the evidence, neither the Comstock nor the Sado epithermal vein model can be rejected; thus the "none of existing models" option is not needed. With respect to the task of delineating permissive tracts, the Sado model would work; without examining many other epithermal occurrences in this region it is not clear that sedimentary rocks are always present as would be expected for Comstock-type deposits. With respect to estimating the number of undiscovered districts, there is a clear preference for the Sado model because of the relatively low tonnages of the 'districts' so far discovered in this region and the similarly low tonnages of Sado districts (Mosier and others, 1986). Although the tonnages of the Alaskan districts cannot be rejected at the 1 percent level as having come from a Comstock-type population, the probability that they come from a Comstock-type population is low. These explored Alaskan districts may be the larger tonnage districts in the region because they were found early in the exploration process, yet they are small relative to most Comstock-type deposits. Thus, because the Comstock epithermal model might bias tonnages of the undiscovered epithermal districts in this part of Alaska and because the geologic setting fits the Sado model, the Sado model seems to be the most appropriate deposit type for these districts.

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